Republic of Kenya

EDICT OF GOVERNMENT

In order to promote public education and public safety, equal justice for all, a better informed citizenry, the rule of law, world trade and world peace, this legal document is hereby made available on a noncommercial basis, as it is the right of all humans to know and speak the laws that govern them.

KS 02-304 (1984) (English): Methods of testing bituminous mixtures for pavements (Draft Standard)

BLANK PAGE

KENYA STANDARD

KS 02-304: 1984
ICS 75.140

Methods of testing bituminous mixtures for pavements

TECHNICAL COMMITTEE REPRESENTATION

The following organizations were represented on the Technical Committee:

Colas (E.A) Ltd.
East African Engineering Consultants
Firoze Construction Ltd.
Ministry of Transport and Communications – Materials Branch
Nairobi City Council
Sir Alexander Gibb and Partners (Africa)
Surtech Ltd.
Kenya Bureau of Standards - Secretariat

REVISION OF KENYA STANDARDS

In order to keep abreast of progress in industry, Kenya Standards shall be regularly reviewed. Suggestions for improvements to published standards, addressed to the Managing Director, Kenya Bureau of Standards, are welcome.

ISBN 9966-07-140-7

C O N T E N T S

Pages

KENYA STANDARD

KS 02-304: 1984
ICS 75.140

Methods of testing bituminous mixtures for pavements

KENYA BUREAU OF STANDARDS (KEBS)

Head Office: P.O. Box 54974, Nairobi-00200, Tel.: (+254 020) 605490, 602350, Fax: (+254 020) 604031
E-Mail: info@kebs.org, Web:http://www.kebs.org

Coast Region
P.O. Box 99376, Mombasa-80100
Tel.: (+254 041) 229563, 230939/40
Fax: (+254 041) 229448

Lake Region
P.O. Box 2949, Kisumu-40100
Tel.: (+254 057) 23549, 22396
Fax: (+254 057) 21814

North Rift Region
P.O. Box 2138, Nakuru-20100
Tel.: (+254 051) 210553, 210555

P R E F A C E

This standard was prepared by the Asphalts Technical Committee under the authority of the Building Industry Standards Committee.

It is one in a series of standards on road marking materials and methods. The standard lays down elaborate sampling and testing methods of asphalts intended for use in road marking.

BS 598: Part 2 and 2, Specification for sampling and examination of bituminous mixtures of roads and other paved areas.

Part 2.Sampling

Part 2. Testing

Acknowledgement is hereby made for the assistance obtained from these sources

KENYA STANDARD

METHODS OF TESTING BITUMINOUS MIXTURES FOR PAVEMENTS

1. SCOPE

This Kenya Standard specifies methods of sampling and testing of all types of bituminous mixtures used in road works and other paved areas.

The tests cover water content, binder content, grading mineral aggregates, hardness number of mastic asphalt and the recovery of soluble binders for examination.

2. DEFINITIONS

For the purposes of this standard, the definitions given in KS 02-99[*] and the following definitions shall apply.

2.1 **increment** — A portion of material taken by one operation from a mass of material. One increment, where not specified in this standard, shall be of about 7 kg taken by a square shovel.

2.2 **bulk sample** — An increment or combination increments taken from a mass of material.

2.3 **laboratory sample** — The whole or a portion of bulk samples taken to the laboratory for testing.

3. GENERAL PRINCIPLES

3.1 Purpose of sampling and testing — Sampling and testing are of equal importance. Every precaution shall be taken to obtain samples which are truly representative of the characteristics of the material being tested.

The purpose of sampling and testing can be one of the following:

(a) Assessment of the average quality of the materials for production control.

(b) Judgment of compliance with the specification for the material.

(c) Establishment of some particular property of a given quantity of material taken from a specific spot in a pavement.

3.2 **Personnel** — The persons employed for sampling and testing shall have been adequately instructed in their respective fields of work in order to acquire the necessary skills to perform their duties efficiently and correctly, and to understand the shortcomings in their techniques.

3.3 **Safety** — All possible aspects of safety cannot be covered in de tail in this document. Every situation shall be considered in its own right.

3.3.1 *Protective Clothing* — appropriate protective clothing shall be worn whenever there is a risk of safety to the individual. The following items shall be considered.
(a) Safety helmets

[*] Glossary of terms relating to bituminous materials (under preparation).

(b) Close fitting overalls, NOT COATS.

(c) Goggies

(d) Face masks

(e) Heat-resistant gloves or gauntlets.

(f) Safety boots

(g) Reflective jackets.

3.3.2 *Loose Clothing* — The sampler shall not wear clothing parts of which may become entangled in machinery.

3.3.3 *Safety Principles* — All personnel involved in sampling shall receive instruction in the hazards associated with moving plants and vehicles and be trained in the treatment of burns to the skin due to contact with hot bituminous material.

3.3.4 *Safety Equipment* — All personnel should be aware of the positions of:

(a) first aid kits;

(b) fire extinguishers;

(c) main power supply switches

3.3.5 Safety in Relation to sampling methods

3.3.5.1 *Sampling from a lorry-load of material* — Immediately before attempting to start and sampling work it is essential that the sampler informs the lorry driver of his intentions.

3.3.5.2 *Sampling during discharge form a mixing plant* — Every possible safety precaution shall be taken as sampling from mixing plants can be highly dangerous.

Samples shall be taken from a suitable platform. Immediately before attempting to start any sampling work it s essential that the plant operator and the lorry driver be informed when samples are being taken.

3.3.5.3 Sampling at the laying site — The Forman shall be kept informed when sampling is going to take place, and the method to be adopted.

The sampler shall always be aware of the potential hazard caused by moving mechanical equipment.

All ancillary equipment shall be kept clear of any traffic movement.

3.3.5.4 *Sampling from the public highway when open to traffic* — The responsible highway authority shall be notified and any regulations concerning traffic control shall be strictly observed.

Sampling personnel shall be kept clear of any traffic movement.

3.3.5.4 Sampling from public highway when open to traffic — The responsible highway authority shall be notified and any regulations concerning traffic control shall be strictly observed.
Sampling personnel should at all times be aware of the dangers to themselves and to the general public when sampling from the public highway.

3.3.6 *Laboratory Safety*

3.3.6.1 *Solvents* — All solvents are dangerous when used without a full understanding of the hazards involved; therefore caution shall always be exercised when using any of the solvents required by this standard.

From the safety point of view, there are certain characteristics of the solvents that shall be known to all concerned.

These are:

(a) Toxicity — Operators can be affected in three ways.

(i) Inhalation of vapour

(ii) Absorption through the skin

(iii) Swallowing

(b) Volatility — Particularly with low boiling point solvents.

(c) Decomposition — Chlorinated solvents decompose in the presence of a naked flame or hot metal surface, producing phosgene which is extremely toxic.

Adequate ventilation is essential in all laboratories where solvents are used; the extraction at floor level s of particular importance.

3.3.6.2 *Equipment* — The main source of danger are as follows:

(a) Moving equipment — Especially laboratory centrifuges which shall be checked for mechanical safety.

(b) Electrical equipment — Routine checks of all electrical equipment shall be carried out.

(c) Pressure and vacuum vessels — Routine safety checks shall be carried out protective shields shall be used at all times.

4. SAMPLING

4.1 General

4.1.1 *Frequency of Sampling* — A sample shall be taken for every 100 tones or less of material. Where the quality is doubtful extra samples shall be taken in order to make more correct decisions about the quality of material.

4.1.2 *Choice of Method of Sampling* — Various factors are associated with different methods of sampling which are important to the economy and progress of work, and therefore due consideration shall be given to choice of sampling method which yields maximum benefit.

4.1.3 *Minimum Mass of Bulk samples* — The minimum mass of the bulk sample shall be in accordance with Table 1.

4.2 Obtaining Bulk Samples — The procedure described in **4.2.1** to **4.2.5** shall apply to all other materials except mastic asphalt which shall be sampled in accordance with **4.2.6**.

TABLE 1 MINIMUM MASS OR BULK SAMPLE FOR DIFFERENT NOMINAL SIZE MATERIALS

MATERIAL	MINIMUM MASS
Nominal size larger than 20 mm	21
Nominal size 20 mm and smaller (excluding mastic asphalt)	14
Mastic asphalt	6

4.2.1 Sampling from a lorry-load (except mastic asphalt)

4.2.1.1 Procedure — Three increments of material of 20 mm nominal size and smaller and four increments for material larger than 20 mm nominal size shall be taken about 100 mm below the surface of the material. Social care shall be taken to remove the complete surface material including any coarse material, which may fall into the hole. The increments shall be taken from different positions as widely specified as practicable but not closer than 300 mm from the side of the lorry

4.2.2 *Sampling during discharge from a mixing plant*

4.2.2.1 *Sampling equipment* — The sampling pan shall be made from steel or cast iron, approximately 1.6 mm thick, and shall be cylindrical with a diameter of 240 ± 10mm and a depth of 75 ± 5 mm. The pan shall be operated in such a way that it can be passed transversely through the center part of the curtain of material being discharged directly form the mixer or from the storage hopper.

4.2.2.2 *Procedure* — The pan shall be positioned prior to discharge to one side of where the curtain of material will fall. During discharge, the pan shall be passed through the falling material at a rate that just prevents any surcharge from building up above the side of the pan., The increments shall be discarded it a surcharge does build up.

(a) discharge direct from a batch-type mixer — An increment shall be taken approximately midway through the period of the discharge of a batch. This shall be repeated on further batches the number of times indicated in Table 2.

NOTE: Sampling shall be carried out when the mixer is about 50 per cent full.

TABLE 2 — NUMBER OF INCREMENTS

NOMINAL SIZE MATERIAL	NO OF INCREMENTS
Larger than 20 mm	3
20 mm and smaller	2

(b) Discharge direct from a continuous mixer or storage hopper —An increment of material shall be taken during a period of continuous discharge from the storage hopper. Care shall be discharged unless the p8rpose of sampling is to examine this particular part of the discharge. Further increment shall be taken as indicated in Table.2.

4.2.3 *Sampling from a paver hopper*

4.2.3.1 *Procedure* — After approximately one half of a lorry-load of material has been discharged into the paver hopper, the lorry shall be withdrawn form the paver and sampling shall take place. If necessary paving operations shall cease:
Three increments of 20 mm nominal size and smaller and four increments for material larger than 20 mm nominal size shall be taken of the heap in the hopper. Special care shall be taken to remove the complete surface material including any coarse material which may fall into the hole.

4.2.4 Sampling from the material around the sugars of the paver

4.2.4.1 Sampling shovel — The sampling shovel shall, where easy access is obstructed by structural members of the paver, the fitted with a suitable handle of approximately 2 m long.

4.2.4.2 Procedure — Two increments shall be taken from each side of the pave, by the use of a square shovel. The increments shall be taken from any position below the augers or from the extension boxes where the material is freely accessible. Increments shall not be taken unless the augers are charged throughout their lengths.

4.2.5 Sampling from the laid-but-not-rolled material

4.2.5.1 General — The method described below is not advisable in the following circumstances:

(a) For wearing course material

(b) For mixtures in which the difference between the nominal size and the thickness being laid is less than 20 mm.

4.2.5.2 Sampling trays — Trays 375 ± 25 mm square shall be made from steel 3.25 ± 0.25 mm thick. The trays shall be not more than 10 mm deep. A steel multi-strand wire at least 3 m long shall be attached to one corner of the tray. The wire attachment shall be designed to withstand effectively the force3s exerted during the passage of the paver over the tray.

NOTE: A wire 9 mm circumference and 4.5 kN breaking load has been found to be satisfactory. Welded attachments have been found unsatisfactory.

4.2.5.3 Procedure — Two trays shall be placed just ahead of the paver, one on each side of the center line of the strip to be laid by the paver. They shall be placed not more tan 10 m apart in the direction parallel to the movement of the paver and shall be positioned so that the trays are not damaged by the paver.

The wires connected to the trays shall be laid, as flat as possible, on the surface to be covered, with the end of the wire outside the area to be covered and shall be prevented from being entangled with the paver. After the material has been laid the wire shall be laid to locate the tray. The corner of the tray shall be lifted by the wire and they tray and the samples shall be eased across the laid material. The two increments so obtained shall be combined to form the bulk sample.

4.2.5 Mastic Asphalt

4.2.6.1 Sampling on site during discharge from a mobile mixer — The material shall be taken as it is being discharged by means of a pan which shall be passed through the curtain at a rate that prevents the build up of any surcharge above the sides of the pan. At least three increments shall be taken and combined.

4.2.6.2 Sampling block material prior to remelting — Material in block form shall be sampled by taking approximately equal increments in pieces from not less than size blocks at random. The total mass of the bulk sample hall be not less than 6 kg.

4.2.7 Sampling of Workable Material in heaps — Three increments of material of 20 mm nominal size of smaller and four increments of material larger than 20 mm size shall be taken from different positions, at least 10 mm from the outer surfaces of the heap. Special care shall be taken to remove the complete surface material including any coarse material, which may fall into the hole. The increments shall be of about 7 kg and shall be taken using a square mouth shovel.

4.2.8 Sampling of finished material

4.2.8.1 Equipment — A core-cutting machine capable of removing cores at least 100 mm in diameter to the full depth of the course to be sampled, or, equipment suitable fore cutting samples of at least 300 mm square to the full depth of the coarse to be sampled.

4.2.8.2 Procedure — The number and location of cores or squares shall be agreed on by interested parties. The cores or squares shall be cut to the full depth of the coarse being sampled; the square shall be not less than 300 m square. The whole of the samples shall be sent to the laboratory in suitable sealed containers.

4.3 Sample-Size, Reduction of Bulk Sample — If it is required to reduce the size of the bulk sample, a sample divider (riffle box) shall be used. The dimensions of the rectangular chutes shall be such that the material flows freely through the divider. For sticky materials a heated sample divider is advantageous.

4.4 Certificate of Sampling — A record shall be prepared at the time fo sampling, giving factual information relating to the bulk sample. The information shall be recorded in the form given below and a copy shall accompany each laboratory sample.

Certificate of sampling

(a) Contrast or job

(b) Supplier and location of mixing plant

© Delivery ticket number when available

(d) Sample identification number

(e) Sampling position (e.g. precise location)

(f) Date and time of sampling

(g) Method of sampling

(h) Reason for sampling

(i) Specification as ordered

(j) Remark

(k) Signature of sampler

(l) Name of sampler in block capitals

5. TESTING

PREPARATORY TREATMENT OF SAMPLE

5.1 Preliminary Inspection — As soon as possible after receipt, the sample shall be inspected and its condition noted.

5.2 Sample Taken After Laying — Where possible the average thickness of one course and the presence of any extraneous material shall be noted. Then all extraneous material shall be removed as completely as possible. If complete removal is not possible the fact shall be reported. Special attention is drawn to the following:

(*a*) *Coated chippings* — These can normally be removed, with a suitable tool, after warming the sample. For this purpose a temperature approximately 40 ^{0}C below the appropriate maximum temperature given in Table 3 is suitable.

If at all possible, the chippings shall be removed by hand before starting the tests. If removal is not possible the fact shall be reported and the tests shall proceed.

(*b*) *Surface dressings* — These can sometimes be removed but any visible penetration of the surface dressing binder into the sample shall be reported.

(c) *Tack coat or blinding grit* — The presence of attack coat or blinding grit shall be reported.

(d) *Fractured aggregate* — The presence of fractured aggregate caused by sampling shall be noted but it shall not be removed.

(e) *Multicourse sample* — Separation of two or more courses may prove difficult and the following procedure shall be followed as far as is practicable. The sample shall be laid face downwards on a clean sheet metal tray and warmed sufficiently, in an oven, to just soften the material so that the courses may be separated. In some cases insertion, at the interface of the courses, of a paint stripping knife with a wide blade, or similar tool, will assist in the separation.

NOTE: Only in cases of extreme necessity should the separation be attempted of the courses of a sample that has become broken. In such a case should separation by hand picking be attempted no great credence can be given to any test results and the fact should be clearly stated in the test.

(f) *Free water* — If free water can be seen or the sample feels wet to the touch, or there is any other reason why the sample may contain water that is unevenly dispersed, the sample, warmed if necessary, shall be broken up into pieces of such a size that the water can readily evaporate. The broken sample shall then be left exposed in a thin layer, on a clean hard surface, in a warm laboratory for at least 24 h. The sample shall then be treated as described in **5.4**.

(g) *Binder drainage* — If any binder drainage is apparent, this shall be reported and the drained material shall be collected and weighed. When the sample has been reduced to a suitable size for testing a proportionate representative weighed fraction of the material shall be added to the portion to be tested. If the drained material cannot be collected, this shall be reported by the analyst.

(h) *Coloured mastic* — In the case of coloured mastic, the colour of a freshly broken surface shall be compared with any relevant colour reference standard.

5.3 Heat Treatment Before Sample Reduction — Samples received which cannot be mixed by hand shall be reheated. In that case the entire sample, or separated courses, shall be heated in a suitable oven until it is just sufficiently soft to be readily mixed and divided. The sample shall be reheated for the shortest possible time, and in no case for more than 4 h, because of the risk of loss of volatile constituents from the binder.

Mastic asphalt and pitch mastic shall be reheated and separated into pieces of about 20 mm size.

Table 5 gives recommended maximum temperatures for reheating the samples. These temperatures are intended to reflect the viscosity of the binder in the sample when tested.

TABLE 3. RECOMMENDED TEMPERATURES OF THE OVEN FOR REHEATING SAMPLES PRIOR TO SAMPLE REDUCTION

TYPE AND VISCOSITY OF BINDER IN SAMPLE	MAXIMUM TEMPERATURE OF VEN
	^{0}C
Bitumen less than 200 s at 40 ^{0}C	60
200 s to a bout 500 s at 40 ^{0}C	70
300 to 450 penetration at 25 ^{0}C	80
200 penetration at 25 ^{0}C	100
70 to 100 penetration at 25 ^{0}C	120
25 to 55 penetration at 25 ^{0}C	140
Leas than 25 penetration at 25 ^{0}C	160

5.4 Sample Reduction for the Determination for Water Content, Binder Content and grading — Inattention to the detail of the procedure given below is frequently the cause of serious errors in the results of the determination of the binder content and grading mixtures.

The whole of the sample, or each portion representing the separate courses shall be weighed and placed on a clean hard surface. The sample shall be mixed thoroughly and reduced to the quantity required for test, as specified in Table 4, either by the use of a riffle box, which may be heated or lightly oiled, or by quartering as described below.

TABLE 4 MASS OF MATERIAL FOR EACH DETERMINATION

mm	kg
50	3.0 to 5.0
40	2.5 to 4.0
28	2.0 to 3.0
20	1.0 to 1.5
14	0.8 to 1.2
10	0.5 to 1.0
6 }	0
3 }	0.5

NOTE: For the sieving extractor method further recommendations are given for the mass of sample to be taken for analysis (see Table 6).

When reduction is by quartering, the sample shall be mixed thoroughly by heaping it into a cone and turning over to form a new cone until the operation has been carried out three times. Each conical heap shall be formed by depositing each shovelful of the material on the apex of the cone. The material which rolls down the sides shall be distributed as evenly as possible, so that the center of the cone shall not be displaced. Some of the larger pieces of aggregate may scatter round the base and these shall be pushed back to the edge of the heap.

The third cone formed from the mixed sample shall be flattened by repeated vertical insertions of the edge of a shovel or board, commencing about the center and working progressively round the cone, lifting the shovel or board clear of the material after each insertion. The heap shall be reasonably uniform in thickness and diameter and its center shall coincide with the center of the cone from which the flattened heap was produced.

The heap shall then be quartered along two diameters which intersect at right angles. The use of a quartering cross of wood or sheet metal, which can be forced through the heap, often facilitates this operation in cases where the material tends to segregate. One pair of diagonally opposite quarters shall

then be shoveled into a heap and the remainder discarded. The process of mixing and reduction shall be repeated on the heap until the mass remaining is about four times the mass of sample required for test.

At this stage the mixing and dividing process shall be continued but the two quarters that would be discarded are put a side for the estimation of water content.

If drained binder was collected during the earlier treatment of the sample (see Clause 5.2) a proportionate amount of binder shall be added to the samples taken for test.

By assuming equal sub-division of the sample after each quartering operation, it is possible to estimate, by weighing the original sample, whether the mass remaining after quartering will meet the specified requirements. If the estimated mass falls outside the limits given in Table 4 the mass of the original sample shall be reduced by one quarter. This shall be done by quartering twice, then rejecting two opposite quarters from the second quartering operation, combining the reminder from the second quartering operation with the material put aside from the first quartering operation and then carrying out the normal procedure described in Clause 5.4.

6. DETERMINATION OF WATER CONTENT

6.1 **Apparatus** — The apparatus, a suitable assembly of which is shown in Figure 1 (a), shall consist of the following items:

(a) A cylindrical container made from brass gauze of about 1 mm to 2 mm aperture size, or alternatively a spun copper tube with a ledge at the bottom on which a removable brass gauze disc rests. The container is maintained, by any suitable means, in position in the top two thirds of a metal pot. The pot is flanged and fitted with a cover and suitable jointing gasket. The cover is held in solvent tight. The essential features of the construction are indicated in Figure 1 (b). It is advantageous to have containers and pots of more than one size, the size employed being appropriate to the quantity of material taken for analysis.

(b) A 12.5 ml graduated receiver suitable for use with solvents of a higher density than water but fitted with a stop cock so that water may be drawn off into a crow receiver as necessary.

(c) A suitable reflux condenser with the lower end g round at an angle of approximately 45 ^{0} to the axis of the condenser.

(d) An electric hot plate.

6.2 Solvent — The solvent shall be trichloroethylene, complying with the requirements of BS 580*

6.3 Method — The part of the sample that was put aside during the sample reduction for the estimation of water content shall be divided into two portions by quartering. One portion shall be retained in a closed container and the other weighed, to the nearest 0.05 per cent of the mass taken, and placed in a well ventilated oven at 100 ^{0}C to 120 ^{0}C for one hour. If, on reweighing the sample, the loss in mass is found to be less than 0.1 per cent no further action is required, but if the loss in mass exceeds 0.1 per cent the portion that was retained shall be weighed and transferred to a dry hot extractor pot.

Sufficient solvent shall be added to permit refluxing to take place and the cover shall be bolted on with dry gasket in position. The receiver and condenser shall be fixed in place and, with an adequate flow of water through the condenser, heat shall be applied to give a steady reflux action.

* Specification for trichloroethylene.

Heating shall be continued until the volume of water in the receiver remains constant. The mass of water shall be recorded.

6.4 Results — Where the water content is required for use in the determination of binder contents by funnel, extraction bottle and sieving extractor methods the results shall be calculated as a percentage by mass of the original sample, to the nearest 0.1 per cent.

When reporting water content this shall be calculated as parts per 100 parts of dry sample, to the nearest 0.1 Part.

7. DETERMIN ATION OF BINDER CONTENT AND GRADING OF MINERAL AGGRETATE

7.1 General

7.1.1 M*ethods* — Four methods for determining binder content are set out in this Clause 7.

These are:

(a) Funnel method

(b) Extraction bottle method — binder determination by difference.

(c) Sieving extractor method.

(d) Hot extractor method.

The methods, when carried out by a skilled operator, will produce comparable test results of all materials, provided that strict attention is paid to the details of test procedure specified in this standard, and the operator has shown that he can achieve the repeatability requirements described later in this standard.

7.2 The Effect of Water Content — It is important, in the examination of bituminous mixtures, to understand fully the effect of the presence of water in the test samples. In the mixtures proceed from essentially dry aggregates and sampled for immediate test there is normally very low water content, i.e. up to 0.2 per cent, but in materials produced from wet aggregates, especially at the lower mixing temperatures and in materials sampled after exposure to the weather, there may be considerable quantities of water. In the methods where the binder is determined by difference, it essential that an accurate estimation of the water content is available to ensure correct binder contents. Similarly, where the aggregate passing the 75 micron sieve is determined by difference, due allowance has to be made for the presence of water.

7.3 Funnel Method — This method shall not be for samples exceeding 1.500 g.

7.3.1 *Apparatus* — The following apparatus is required:

(a) A suitable strong beaker, provided with a cover and a stout stirring-rod, to be used for the solvent extraction of the sample.

(b) A settling beaker of a suitable size to hold the binder solution and the aggregate passing the 75 µm sieve.

(c) A 75 µm test sieve of 75 mm or 100 mm diameter, and complying with the requirements of BS 410* or any relevant Kenya Standard.

* Specification for test sieve.

(d) A funnel of suitable material with the top edge ground flat, and of suitable diameter, referred to as the larger funnel.

(e) A glass plate of suitable diameter with a central hole of about 20 mm diameter, ground to register with the ground rim of the funnel.

(f) A 100 – mm diameter funnel of suitable material with a stem approximately 100 mm long, referred to as the small funnel.

(g) No. 5 Whatman filter papers (or equivalent) of suitable size.

(h) A set of test sieves.

7.3.2 *Solvent* — The standard solvent shall be trichloroethylene complying with BS 580 or dichloromethane complying with the requirements of BS 1994[+].

7.3.3 *Method* — A sample for test, complying with mass requirements given in Table 4, shall be obtained by the method described in clause 5.4.

The filter paper shall be folded in the manner shown in Figure 2, dried in an oven at 110 ^{0}C to 120 ^{0}C for more than 60 min, cooled in desiccator weighed without delay and then placed in the larger funnel, which shall be suitably supported for collecting the filtrate.

The sample shall be weighed (to the nearest 0.05 per cent of the mass taken) into the weighed beaker. The stirring rod shall be placed in the beaker, solvent added and the beaker covered. The quantity of solvent and the period before decantation shall be adjusted so that the concentration of the binder in solution is kept comparatively low otherwise the speed of filtration will be retarded.

The solution in the beaker shall be poured immediately into the weighed settling beaker through the 75 µm test sieve; care shall be taken to prevent damage to the sieve, i.e. by protecting with a larger mesh sieve.

The bulk of the mineral matter in suspension in the solution in the settling beaker shall be allowed to form a 'cake' in the bottom of the beaker. The solution shall then be carefully decanted through the small funnel, which passes through a cork in the hole in the glass plate, and into the centre fold of the filter paper having just been wetted with solvent.

Fresh solvent, which may be warm, shall be added to the sample in the first beaker. The sample shall be stirred as necessary to filtrate extraction and the process described above repeated until the filtrate becomes colorless.

During the process of transferring the solution from the extraction vessel to the settling beaker every effort shall be made to transfer the material passing the 75 µm test sieve into the settling beaker.

While the sample is being washed it will be found advantageous to maintain the level of the solution in the filter paper above the lower end of the stem of the small funnel. The small funnel shall be kept covered with a clock glass during filtration so that evaporation of the solvent is minimized.

When extraction of the binder from the sample is completed the aggregate retained on the 75 µm sieve shall be added to the contents of the sample beaker. The beaker and contents shall then be placed in a well ventilated oven at a temperature of 100 ^{0}C to 120 ^{0}C and dried to constant mass. Material shall be deemed to be at constant mass when the difference between successive weighings, carried out at half-hourly intervals, does not exceed 0.05 per cent.

[+] Dichloromethane (methylene chloride).

When decantation is complete the glass plate shall be removed as necessary to enable the filter paper to be washed free from binder. The filter paper and its contents shall be dried to constant mass under similar conditions to the beakers and their contents.

When constant mass has been achieved, the material shall be cooled in a desiccator for the final weighing. The soluble binder content, S, shall be calculated on the dry sample by means of the following equation:

$$S = 100\frac{100\left(M_1 - M_2\right) - M_1 P}{M_1\left(100 - P\right)}\left(percentage\,by\,mass\right)$$

when,

M_1 = the mass of undried sample (g);

M_2 = the mass of insoluble material in both beakers and the filter paper (g);

P = the percentage by mass in sample.

7.3.4 *Grading of Mineral Aggregate* — Provided that decantation of the binder solution into the settling beaker has been carried out immediately after stirring the sample, the proportion of material passing the 75 µm sieve shall be less than 1.5 per cent of the total aggregate by weight. When this condition is satisfied, the sample shall be graded using the general principles described in KS 02-95*, taking care not to overload the sieves, particularly those of fine mess. The aggregate shall then be separated into two fractions:

(a) Coarse-aggregate fraction, retained on a 2.36-mm sieve, and

(b) Fine-aggregate fraction, passing through a 2.36-mm sieve.

The masses of the two fractions shall be noted. All the coarse-aggregate shall be graded on a nest of sieves appropriate for the mixture. For the grading of the fine-aggregate fraction, a sample of about 150 grams shall be taken. When required the fine-aggregate fraction shall be split using a sample divider. When only a portion the fine-aggregate is graded, the masses of the graded fine-aggregate shall be multiplied by the ratio of the total mass of fine-aggregate fraction to the mass of the portion taken.

The amount of material passing the 75 µm sieve will equal the sum of means of material in the filter paper and in the settling beaker.

7.3.5 *Results and the Reporting of Results* — The result shall be expressed as a percentage by mass and shall be calculated to the nearest 0.1 per cent. The actual calculations carried out will depend upon the form in which the results are required for comparison with the specification for the mixture.

The binder content shall be reported to the nearest 0.1 per cent by mass of the total dry sample. The grading of the mineral aggregate shall be reported to the nearest 1.0 per cent except for material passing the 75 µm sieve which shall be reported to the nearest 0.1 per cent.

7.4 Extraction Bottle Method: Binder Determination by Difference

7.4.1 *Apparatus* — The following apparatus is required.

* Specification for natural aggregates for concrete

(a) Metal bottles of capacity appropriate to the size of sample being analysed, with wide mouths and suitable closures.

(b) A machine which will rotate the bottles horizontally about ther longitudinal axes at a speed of approximately 10 rev/min to 30 re/min.

(c) A pressure filter of appropriate size (one taking a filter paper of 270 mm diameter is suitable). An air pump for supplying oil-free air at about 200 kpa.

(d) A supply of No. 5 Whatman filter papers, or equivalent, to fit the pressure filter.

(e) A funnel capable of supporting three 200 mm or 300 mm diameter sieves over the filling orifice of the pressure filter.

(f) A set of sieves.

7.4.2 *Solvent* — Dichloromethane (methylene chloride) or trichloroethylene complying with the requirements of BS 1994 and 580 respectively.

7.4.3 *Method* — The sample for test, complying with the mass requirements given in Table 1, shall be obtained by the method described in **5.4**. If water presence is suspected in the sample, the water content shall be measured by the method described in Clause 6.

NOTE: It is essential that the water content is known as any errors in the estimation of water content will directly affect the estimation of binder content.

The cold sample shall be weighed, to the nearest 0.05 per cent of the mass taken, and shall be introduced into the metal bottle of the appropriate size. Dichloromethane shall be added to the sample to give a solution of approximately 3 per cent to 4 per cent concentration of soluble binder.

The bottle shall be closed and rolled on the bottle rotating machine for the time given in Table 5, but for material which has been on the road for some time the rolling time may need to be extended to ensure extraction of soluble binder.

After the specified rolling time the contents shall be allowed to stand for at least 2 min, so that. The aggregate remaining in the bottle shall then be shaken with about half the quantity of solvent used originally or about 1 000 ml, which-ever is the smaller. Immediately after shaking, the solution shall be poured through the nest of sieves into the pressure filter, extreme care being taken to ensure no loss of mineral matter. The solution shall then be forced through the pressure filter. This process shall be repeated until no discolouration of dichloromethane is visible and the washings are visibly free from material in suspension.

TABLE 5 TIME REQUIRED FOREXTRACTION (EXTRACTION BOTTLE METHOD: BINDER DETERMINTION BY DIFFERENCE)

	TYPE OF MATERIAL	APPROPRIATE TIME OF ROLLING
(a)	Macadams other than dense macadams, containing cut-back bitumen	5
(b)	Dense macadams and cold asphalt containing cut-back bitumen	10
(c)	Macadams other than dense macadams, containing penetrating grade bitumen	20
(d)	Asphalt and dense macadams containing penetrating grade bitumen	30

At this point the contents of the bottle shall be carefully transferred on the nest of sieves. The bottle shall then be rinsed once to remove as much of the mineral matter as possible. The final washings shall be forced through the pressure filter.

The aggregates in the sieve shall be transferred without any loose to a metal tray and dried. The metal bottle shall also be dried and any mineral matter in the bottle shall be transferred to the tray with the reminder of the aggregate. The matter of the aggregate in the tray shall be recorded.
The filter paper and the mineral matter passing the 75 µm sieve shall be carefully removed from the pressure filter, dried and weighed.

The soluble binder content, S, shall be calculated on the dry sample by means of the following equation:

$$S = 100\frac{(M_1 - M_2) - M_1 P}{M_1(100 - P)}(percentage\,by\,mass)$$

where,

M_1 = the mass of undried sample (g):

M_2 = the mass of aggregate (g);

P = the percentage by mass of water in sample.

7.4.4 *Grading of Mineral Aggregate* — Provided that the aggregate remaining in the metal tray is dry and was thoroughly washed, the aggregate shall then be graded in accordance with '**7.3.4**.

7.4.5 *Results and the Reporting of Results* — The results shall be reported as in **7.3.5**.

7.5 Sieving Extractor Method

(*a*) A sieving extractor for simultaneous extraction of the binder and sieving of the aggregate, consisting of a metal cylindrical vessel 200 mm in diameter, having a domed top with an orifice which can be closed with a liquid-tight closure. The height of the vessel shall be at least 90 mm, but for samples containing aggregate retained on a 31.5 mm sieve a height of 120 mm is necessary. The walls of the vessel shall be of bigger thickness when analyzing samples containing large aggregate. The base of the vessel may be formed by 2.36 mm test sieve mesh.
The cylindrical vessel is mounted above a nest of sieves of appropriate fine mesh size, the sieves being separated from adjacent sieves by suitable washers, to prevent any leakage of solvent. The sieves are 200 mm diameter and may be either 12.5 mm or 25 mm deep.

By means of a clamping device, the assembly is attached to a baseplate, to which a rocking motion can be imparted by attachment to a fly-wheel and electric motor drive. The assembly rocks through an angle of approximately 22^0 at a frequency of 2 Hz. The baseplate is fitted with a draincock.

(*b*) Volumetric flask of 250 ml, 500 ml, 1 000 ml and 2 000 ml capacity.

(*c*) A centrifuge capable of developing an acceleration of about 25 000 m/g^2 calculated in accordance with the following equation.

Acceleration = $1.097\ n^2\ r \times 10^{-5}$

where,

N = the revolutions per minute; and

r = the radius in millimetres to the bottom of the tubes (internal), when rotating.

The tubes shall be closed with caps such that no loss of solvent is permitted during centrifuging.

(*d*) A filtration apparatus (*see* Figure 4) comprising a metal bottle such as described in **7.4.1**, a porous filter thimble, tubing and a 50-ml burette.

The porous filter is of porcelain, alumina or similar material, 20 mm long by 20 mm diameter and of up to 4 µm pore diameter. The filter is closed by sealing in, to within 5 mm of the bottom, a length of metal tubing, approximately 300 mm long by 5 mm bore, that passes through a supporting ring of cork or metal that is mounted just inside the open end of the filter (*see* Figure 5). A Cement paste composed of copper oxide powder (prepared by the direct oxidation of copper wire) of about 425 µm particle size, and phosphoric acid is used to seal the joint. The joint is left to dry out for a few hours. Alternatively, a rubber stopper or sealing compounds such as plaster of Paris mixed with asbestos fibre may be used. Care shall be taken to ensure that that the seal does not split the filter thimble.

NOTE: The two pieces of apparatus under (*c*)and (d) are alternatives.

(*e*) A metal bottle of about 2 500 ml capacity fitted with a rubber stopper.

(*f*) A recovery apparatus comprising a water bath, with an electric heater capable of maintaining boiling water in the bath throughout the recovery procedure, a flat-bottomed flask of 200 ml of 250 ml capacity, a vacuum gauge, a vacuum reservoir and a filter pump.

Figure 6 illustrates a typical recovery apparatus which can be used.

(*g*) A set of sieves.

TABLE 6. RECOMMENDATIONS FOR THE SIZE OF SAMPLE, SIEVES AND VOLUME OF SOLVENT TO BE USED FOR
TEST BY THE SIEVING EXTRACTOR METHOD

TYPE AND SIZE OF MATERIAL	SAMPLE MASS	RECOMMENDED SIEVES (12.5 MM AND 25 MM DEEP)		MINIMUM VOLUME OF SOLVENT*
	g	mm	micron	ml
40 mm nominal size				
Macadams	2 500 – 3 750			
Rolled asphalt	2 500 – 3 750	3.35-1.18	600 300+ - - 75	500
28 mm nominal size		-2.36 -	600 300 212 150 75	500
Macadams	1 500 – 2 250		600 300 - - 75	2 500
Rolled asphalt	1 500 – 2 2500	3.35 – 1.18	600 300 212 150 75	3 500
20 mm and 14 mm nominal size	20 mm 14 mm	-2.36 -		
Macadams	1 000 – 1 500 800 -1 200	3.35-1.18	- 300 - - 75	2 000
Rolled asphalt	1 000 - 1500 800 -1 200	- 2.36 -	600 - 212 150 75	2 500
Coated chippings	2 000 – 3 000 2 000 – 3 000	3.35 – 1.18	- 300 - - 75	2 000
10 mm nominal size and smaller				
Macadams	700 – 1 100	3.35-1.18	600 - - 150 75	2 000
Cold asphalt, coarse	600 - 900	- 2.36 -		
Cold asphalt, fine	600 - 900	- 2.36 -	600+ - 212 150 75	
Mastic asphalt percentage				
Retained 2.36 mm 5	500 - 750	- 2.36 -	600 - 212 150 75	2 500
Rolled asphalt percentage				
Retained 2.36 mm 18	700 – 1 100	- 2.36 -	600 - 212 150 75	2 500
Rolled asphalt percentage				
Retained 2.36 mm 10	700 – 1 000	- 2.36 -	600 - 212 150 75	2 500
Coated chippings	2 000 – 3 000	3.35 – 1.18	- 3 00 - - 75	2 00

7.5.2 *Reagents* — The following reagents are required:

(a) The solvent shall be dichloromethane (methylene chloride) complying with the requirements of BS 1994.

(b) silica gel, crushed to pass a 75 µm sieve, which has been dried overnight at 115 ± 5 ^{0}C.

7.5.3 *Method* — A sample for test, complying with the mass requirements given in Table 6, shall be obtained by the method described in **5.4**.

The sample shall be weighed to the nearest 0.05 per cent of the mass taken.

The sieves necessary for the determination shall be collected and inspected for damage and cleanliness, they shall then be assembled on the base of the sieving extractor so that all joints are free from grit and so that they nest without locking together due to damage or distortion of the rims of the sieves. The clamps shall be adjusted evenly so that no leakage of solvent through the joints is possible.

Dichloromethane, measured by means of volumetric flasks, shall be added to the nest of sieves in the quantity required to meet the minimum requirements given in Table 6. Should sieves additional to those envisaged in Table 6 be used the volume of solvent added shall at least cover the mesh of the coarsest sieve.

The joints of the sieves shall be checked for freedom from leaks without delay and then the weighed sample shall be introduced onto the top sieve. If the sample has been heated to assist in sample reduction, it is important that it should have been cooled before-hand. A weighed quantity of silica gel shall be added to absorb any water present in the sample. The amount of silica gel shall be at least equal in mass to the mass of water estimated to be present in the sample.

* See Clause 7.5.3
+ 25 mm deep sieve

The orifice in the top shall be closed by a liquid-proof closure and the apparatus set in motion. Shaking shall continue for the period given in Table 7.

TABLE 7. TIME REQUIRED FOR EXTRACTION (SIEVING EXTRACTOR METHOD)

TYPE OF MATERIAL	SHAKING TIME
	Min
Coated chippings	10
Bitumen macadam	10
Cold asphalt	15
Rolled asphalt	15
Mastic asphalt	20

After shaking for the specified period the liquid-proof closure shall be replaced by one which will allow entry o air whilst preventing the spillage of solution. The solution binder in dichloromethane shall be run through the draincock into the metal bottle. During drainage, shaking may be continued provided that it is not prolonged, thereby degrading the aggregate. Under certain conditions drainage may be very slow due to a liquid lock forming on the fine sieves and in this case drainage may be assisted by carefully blowing a small quantity of air through the sieves from below, via the draincock, and by continuing the shaking.

A portion of the binder solution shall be freed from insoluble matter, either by means of centrifuging for 20 min in completely closed tubes, or by means of the filtration apparatus using a dry, binder-free filter. If filtration is prolonged, due to fine mineral matter being present in the binder solution, inaccurate results may be obtained and in this case centrifuging is essential.
The loss of solvent shall be minimized during extraction, and centrifuging or filtration procedures.

The procedure from this point shall be carried out in duplicate. When the level of the binder content of the sample is unknown, it is advisable to recover the binder from one aliquot portion of solution before proceeding with the duplicate recovery to ensure compliance with the mass restrictions given below.

The flat-bottomed flask shall be weighed to the nearest 0.01 g. A sufficient amount of the centrifuged or filtered solution shall be measured into the flask, using the burette, to give a residue to 0.75 g to 1.25 g of soluble binder after evaporation of the solvent. An estimate of the volume of solution (aliquot portion) required is given below:

$$Aliquotportion(ml) = \frac{Total\ volume\ of\ solvent\ (ml) x 100}{Mass\ of\ sample\ (g)\ x\ estimated\ percentage\ of\ soluble\ binder\ in\ sample}$$

The solvent shall be removed from the binder solution by connecting the flak to the recovery apparatus, immersing the flask to approximately half its depth in the boiling water and distilling off the solvent. While the distillation is proceeding, the flask shall be shaken with a rotary motion so that the binder is deposited in a thin layer on the walls of the flask. Pressure, above atmospheric, shall not be allowed to develop in the flask during the evaporation of the solvent and it is recommended that the distillation be carried out under reduced pressure. If reduced pressure is used the pressure shall be not less than 60 kpa.

(a) for petroleum bitumen, the pressure shall be further reduced to 20 kpa in 1.5 min and maintained at this pressure for a further 3.5 min.

(b) For cut-back bitumens, the pressure shall be allowed to increase to approximately atmospheric pressure; it shall then be reduced to 60 kpa in 1.5 min and maintained at this pressure for a further 3.5 min.

The flask shall then be removed from the bath and air admitted to the apparatus to increase the pressure to atmospheric. The flask shall be wiped dry and then disconnected, care being taken to prevent t he entry into the flask of any water that may have collected where the rubber s topper joins the flask. The last traces of solvent that remain in the flask shall be removed by a gentle current of clean, oil-and water-free air.

The flask shall then be cooled in a desiccator and weighed to the nearest 0.01 g. If the quantity of soluble binder recovered lies outside the limits 0.75 g and 1.25 g the recovery shall be repeated with another portion of the solution having the volume suitably adjusted.

If the difference between the duplicate recoveries is greater than 0.02 g these results shall be rejected and recovery of the binder shall be repeated in duplicate on further aliquot portions. The average of the duplicate determinations shall be used for calculation of the binder content.

The soluble binder contents S, shall be calculated by means of the following equation:

$$S = \frac{1000zV}{vm(100-P)} \qquad \left(1+\frac{z}{dv}\right)(percentageofmass)$$

where,

m = the mass of undried sample (g);

z = the average mass of binder recovered from the two aliquot portions (g);

V = the total volume of solvent (ml);

V = the volume of aliquot (ml);

D = the relative density 15.5/15.5 ^{0}C (1.0 in the case of bitumen);

P = the percentage of mass of water in sample (see Clause 6).

7.5.4 *Grading of Mineral Aggregate* — The aggregate remaining in the sieving extraction shall be washed free from solution and aggregate passing the 75 µm sieve using several washes each of about 750 ml of dichloromethane. The rinsing process may be assisted by shaking the sieves briefly.

The apparatus shall be dismantled, the sieves placed in suitable trays and the aggregate dried in a warm ventilated cupboard. The aggregate retained on the top sieve shall be graded on appropriate sieves using the methods described in KS 02-95. To ensure complete grading of the finer sieves, each sieve shall be covered by a spare fine sieve and shall then be shaken over a suitable receiver. Any material that is collected in the receiver shall be added to the next finer siever.

When grading has been completed the sum of the masses of aggregate retained on the individual sieves shall be checked by combining the graded aggregate and re-weighing.

The amount of material passing the 75 µm sieve shall preferably be recovered by filtering the drainings from the nest of sieves through the filter paper. A pressure filter may be used for this operation.

NOTE: The mass recovered will include the silica gel added.

Alternatively, the material passing the 75 µm sieve may be calculated as follows by difference, after making allowance for any water present in the sample; i.e.

Mass of aggregate = mass of sample – mass of water + mass of total binder + mass of aggregate
Passing 75 µm sieve not passing 75 µm sieve.

7.5.5 *Results and the Reporting of Results* — The results shall be reported as in **7.3.5**.

7.6 Hot Extractor Method — This method is not suitable for the analysis of mastic or pitch mastic. However, the water content of these materials may be determined using this apparatus, as specified in Clause 6.

7.6.1 Apparatus — The following apparatus, a suitable assembly of which is shown in Figure is required:

(a) A cylindrical container made from brass gauze of about 1 mm to 2 mm aperture size or alternatively, a spun copper tube with a ledge at the bottom on which a removable gauze disc rests. The container is maintained, by any suitable means, in position in the top two thirds of a metal pot. The pot is flanged and fitted with a cover and suitable jointing gasket. The cover is held in position by appropriate means. The essential features of the construction are indicated in Figures 2 and 3; it is advantageous to have containers and pots of more than one size, the size employed being appropriate to the quantity of material taken for analysis.

(b) A 12.5-ml graduated receiver conforming to BS 756, Type 2 or a receiver of the same type, i.e. suitable for use with solvents of a higher density than water, but fitted with a stop cock so that water may be drawn off into a Crow receiver as necessary., The receivers may be fitted with ground glass joints when an adaptor will be necessary to connect the receiver to the cover of the pot.

(c) A suitable reflux condenser with the lower end ground at an angle of approximately 45^{0} to the axis of the condenser.

(d) A suitable heater such as an electric hot plate. (Gas rings shall not be used because of the risk of decomposition of any free solvent vapour and the corrosion of the pot if made of steel.)

(f) A supply of No. 1 and No. 5 Whatman filter papers (or equivalent).

(g) Where necessary, a container suitable for collecting the aggregate0washings.

7.6.2 *Solvent* — The solvent shall be trichloroethylene complying with BS 580.

7.6.3 *Method* — The sample for test, complying with the mass requirement given in Table 1, shall be obtained by the method described in Clause 5.4.

A No. 1 Whatman filter paper (or equivalent) shall b fitted into the cylindrical container to form a complete lining and the whole dried at $100\ ^{0}C$, cooled in a desiccator and weighed.

The sample shall be carefully placed in the lined container and the whole weighed to the nearest 0.05 per cent of the mass taken. The weighing operations involving the dried filter paper shall be carried out as rapidly as possible to prevent undue absorption of moisture from the atmosphere. The container shall be placed in the pot and sufficient solvent, according to the size of the extractor, shall be poured over the sample.

The cover shall be bolted on with the dry gasket in position, the receiver and condenser shall be fitted in place and heat applied to the pot and so adjusted as to avoid intense local heating, but at the same time to ensure a steady reflux rate of two to five drops per second falling from the end of the condenser.

Any water present in the sample will collect in the receiving tube, while the solvent will flow back over the sample and drain through the filter paper into the bottom of the pot.

If the amount of water collected exceeds the capacity of the receiver, the distillation shall be discontinued, the condenser disconnected, and a measured portion of the water removed by means of a pipette and pipette filter. The apparatus shall then be re-assembled and distillation restarted. If a stop cock is fitted to the receiver the water may be drawn off and measured in a Crow receiver.

Heating shall be continued until extraction is complete and water ceases to collect in the receiver.

NOTE: 1. If the apparatus is permitted to stand for more than about 2 h there is the possibility of water from the atmosphere being absorbed by the filter paper. It is therefore recommended that the initial period of refluxing should be of sufficient duration to ensure that all of the water is collected without interruption except for emptying the receiver.

The washed mineral aggregate with its container shall be removed and dried to constant mass at a temperature of 100 ^{0}C. Material shall be deemed to be at constant mass when the difference between successive weighings at half-hourly intervals does not exceed 0.05 per cent.

NOTE :2. For convenience, it is recommended that the successive weighings to determine constant mass should be carried to whilst the material is hot.

When constant mass has been achieved, the cylinder and contents shall be cooled in a desiccator before weighing.

In order to correct for any fine material present in the solution at the end of the test, the whole of the solution shall be filtered through a suitable grade of filter paper, e.g. Whatman No. 5, or centrifuged, and the mass of insoluble matter determined.

The soluble binder content, S, shall be calculated on the dry sample by means of the following equation:

$$S = 100x\frac{M_1 - (M_2 + W + M_3)(percentbymass)}{M_1 - W}$$

where,

M_1 = the mass of undried sample (g);

M_2 = the mass of recovered aggregate in cylindrical container(g);

W = the mass of water collected in test (g);

M_3 = the mass of residue obtained on filtering or centrifuging the solution (g).

7.6.4 *Washing of Mineral Aggregate* — The dry aggregate shall be carefully transferred from the filter paper to a metal bottle of suitable size. The filter paper shall be brushed to remove as much of the adhering metal bottle. The brush filter paper shall also be transferred to the metal bottle. The brush filter paper shall be replaced in the cylindrical container and the container and paper weighed. Any increase in mass over the original mass of the container and paper shall be added to the mass of material passing 75 µm sieve, found in the reminder of the grading.

Solvent shall be added to the aggregate in the metal bottle until it just covers the aggregate. The bottle shall be sealed and shall be rolled manually or on a bottle rotating machine (see **7.4.1** (*b*)) for about 5 min, in order to thoroughly wet and separate the particles of aggregate. The wash solvent shall be poured through a 75-µm sieve which shall be protected by a 1.18-mm sieve, care being taken to avoid,

as far as possible, the transfer of the coarse particles of aggregate. The washings shall be collected in either a clean container or directly in a pressure filter. If a pressure filter is used it shall be fitted with a No. 5 Whatman filter paper and the solvent shall be forced through the paper under pressure. When a pressure filter is not used the insoluble material passing through the aggregate caused by the complete washing procedure.

The washing procedure shall be completed by repeating the above process until the aggregate in the bottle is substantially free from material passing the 75 µm sieve; when this stag e has been reached the contents of the bottle shall be completely transferred either to the top sieve or, when the sample is large, to a suitable tray, rinsing the inside of the bottle as necessary.

7.6.5 *Grading of Mineral Aggregate* — Provided that the aggregate was thoroughly washed, the proportion of material passing the 75 µm sieve remaining with the aggregate should be small, i.e. less than 1.5 per cent of the total aggregate (see Note). If this is so, the aggregate on the sieve and/or tray shall be dried and graded using the general principles described in KS 02-95 taking particular care to ensure that the sieves, especially the fine mesh sieves, are not overloaded. Where necessary the aggregates shall be separated into two fractions;

(1) coarse-aggregate fraction, retained on a 3.35-m or 2.36 –mm sieve, and

(2) fine-aggregate fraction, passing through the 3.35-mm or 2.36-mm sieve. The masses of the two fractions shall be noted.

NOTE: If the amount of material passing the 75 µm sieve found with the aggregate is greater than 1.5 per cent of the total aggregate, the result for the material passing the 75 µm sieve may be incorrect and the washing of aggregate procedure should be modified.

All of the course-aggregate fraction shall be graded on a nest of sieves appropriate for the mixture. For the grading of the fine-aggregate fraction a sample of 100 g to 200 g shall be taken. When required the fine-aggregate fraction shall be taken. When required the fine-aggregate fraction shall be split using a sample divider. The fine aggregate shall be graded on a nest of sieves of appropriate mesh sizes. When only a portion of the fine-aggregate fraction is grade, the masses of graded fine aggregate shall be multiplied by the ratio of the total mass of the fine-aggregate fraction to the mass of the portion taken for grading.

To obtain the total amount of material passing the 75 µm sieve the following shall be added together.

(a) The increase in mass of the cylindrical container and filter paper after removal of the aggregate for grading.

(b) The mass of residue recovered from the solution in the pot.

(c) The loss in mass caused by washing through the 75 µm sieve.

(d) The mass